UNIVERSITI TEKNOLOGI MARA

A RULE-BASED IMAGE SEGMENTATION METHOD AND NEURAL NETWORK MODEL FOR CLASSIFYING FRUIT IN NATURAL ENVIRONMENT

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of the requirements for the degree of
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CONFIRMATION BY PANEL OF EXAMINERS

I certify that a panel of examiners has met on 17th September 2015 to conduct the finalexamination of Hamirul'Aini Binti Hambali on his Doctor of Philosophy thesis entitled "A Rule-based image segmentation method and neural network model for classifying fruit in natural environment" in accordance with Universiti Teknologi MARA Act 1976 (Akta 173). The Panel of Examiners recommends that the student be awarded the relevant degree. The panel of Examiners was as follows:

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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the result of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

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ABSTRACT

Image segmentation and object classification processes are gaining importance in image processing applications such as in agricultural area. In general, image segmentation divides a digital image into multiple areas while object classification classifies objects into the correct categories. However, segmentation and classification processes arechallenging for images captured in natural environment due to the existence of non-uniform illumination.Different illuminations produce different intensity on the object surface and thus lead to inaccurate segmented images. The low quality of segmented images may lead to inaccurate classification. Therefore, this thesis focuses on the improvement of segmentation methods and development of classification model for images captured in natural environment. Based on the previous researches, most existing segmentation methods are unable to accurately segment images under natural illumination. Therefore, this research has developed three improved methods which are able to segment images acquired in natural environment satisfactorily.The first method is an improved thresholding-based segmentation (TsN), which adds algorithms of inverse process and adjustment on threshold value. However, there is some inconsistency in the segmentation of lighter colourimages such as green, yellow, and yellowish-brown. Therefore, another segmentation method has been developed to address the problem. The new method, named as Adaptive K-means, is developed based on clustering approach. This method adds separation and inverse processes to the algorithm in order to produce the best segmented images. However, Adaptive K-means has limitation in segmenting black images. Therefore, the improved thresholding-based segmentation (TsN) is integrated with the Adaptive K-means thus resulting in rule-based segmentation namely TsNKM method. This robust method is able to segment images for all categories of objects at a commendable percent accuracy rate. For object classification, some methods have the ability to identify objects as good as human experts who normally classify objects based on visual perception. However, classifying objects in natural environment is difficult due to the presence of direct illumination on the object surface.Therefore, this research has developed a semi-supervised Fuzzy c-means (FCM) and neural network (NN) model that are able to classify objects based on their surface colour. The result of the NN model shows that, with the network configuration of 6-7-4, the NN model works very well for objects exposed to the natural illumination.To justify our proof-of-concept, the proposed segmentation methods and classification model are tested on jatropha fruit images and the results show that the developed methods and model are able to improve the segmentation and classification accuracy, respectively.

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